ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)

DATE: February 1999

BUDGET ACTIVITY: 2 - Applied Research

PE NUMBER AND TITLE: 0602709A Night Vision Technology

PROJECT: DH95

COST (*In Thousands*)	FY1998 Actual	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
DH95 Night Vision and Electro-Optic Technology	16563	19008	20111	20966	21624	20527	21870	23436	Continuing	Continuing

A. Mission Description and Budget Item Justification: This program element (PE) develops core night vision and electronic sensor technologies for Army weapons systems. Advanced next generation focal plane arrays, both mega-pixel infrared and multispectral, are being developed that will see farther, provide advanced signal processing, and improve performance on the dirty battlefield. Advanced driver electronics are being developed to reduce power consumption and improve the contrast and brightness of miniature flat panel displays for future aviation, infantry, armored vehicle, and field maintenance applications. Multi-wavelength and micro-laser sources will provide affordable, high performance technology options for the individual soldier, and tactical laser rangefinding, designating, obstacle avoidance, laser radar, and missile countermeasures. Extended battlespace micro-sensors will provide a revolutionary increase in battlespace awareness that will improve soldier survivability, lethality, and situation awareness, and enable commanders and staffs to plan, decide, and execute operations with greater speed and tempo. Aided/automatic target recognition technologies will enable dramatic reductions in the time to acquire targets, detect land mines, and collect intelligence data while also reducing the warfighter's cognitive workload. Hardware-in-the-loop multispectral sensor simulations are being developed that will allow end-to-end predictive modeling, hardware design, and evaluation of new technologies in a virtual environment, while allowing warfighters to test these capabilities, develop tactics and techniques, and train in parallel with the hardware development process. This program element supports Force XXI Land Warrior, upgrades for Force XXI weapons systems, and Army After Next future systems. Work in this program element is consistent with the Army Science and Technology Master Plan (ASTMP), the Army Modernization Plan, and adheres to Tri Service Reliance Agreements on Sensors and Electronic Devices. Work in this program element is related to and fully coordinated with PE 0602712A (Countermine Technology), PE 0602270A (Electronic Warfare Technology), and PE 0603710A (Night Vision Advanced Technology). This program is managed primarily by the Communications-Electronics Research, Development and Engineering Center (CERDEC), Night Vision Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

FY 1998 Accomplishments:

- 5001
  - Evaluated the practicality and affordability of monolithic growth techniques for large single spectrum staring focal plane arrays that will improve focal plane performance, reliability, and manufacturing yield.
  - Developed validated staring imager performance models to support design and evaluation of advanced next generation staring sensors.
  - Demonstrated smart on-chip read-out circuit functions such as spatial and temporal filtering that can provide significant improvements in target to clutter contrast.
  - Evaluated multi-color large staring focal plane array technologies with hyperspectral filtering for overhead battlefield surveillance systems that will improve theater battlefield awareness and provide the capability to detect high value targets that are camouflaged or concealed. This is a joint program with Space and Missile Defense Command (SMDC).

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- 3096 – Evaluated and characterized uncooled focal plane array materials that are sensitive from the visible through near infrared spectral region and that can exploit the night time illumination effects of naturally occurring "sky-glow" radiation that is not detectable with current image intensifier technology.
  – Established sensitivity, resolution, and read-out circuit requirements for an uncooled, solid state near infrared imaging focal plane array to replace current generation image intensifier tubes.

FY 1998 Accomplishments: (continued)

- 1420 – Developed laboratory variable repetition rate laser pump module and combine with nonlinear conversion modules as needed for different applications such as target designation, eyesafe rangefinding, and laser radar.
- 4000 – Integrated advanced infrared and millimeter wave radar ATR evaluation capability for multi-sensor reconnaissance, search and target acquisition applications.
  – Incorporated low power consumption miniaturized high performance components into ATR processing hardware for compact sensor applications.
  – Developed synthetic aperture radar (SAR) automatic target recognition (ATR) evaluation methodology to characterize performance and support assessments of automation technologies.
  – Characterized synthetic FLIR imagery for ATR evaluation application.
- 3046 – Developed and integrated real-time multi-spectral effects (visible, near infrared, mid infrared) into synthetic scene generation capability to provide realistic sensor effects for sensor prototyping and wargame simulation and to reduce develop time.
  – Enhanced mine signature simulations for infrared and ground penetrating radar sensors and evaluation of aided mine detection algorithms in support of land mine center of excellence.

Total 16563

FY 1999 Planned Program:

- 4950 – Develop/design architecture for partitioning smart integrated circuit processing hardware functions between on- and off-focal plane to improve sensor performance and reduce processing hardware requirements for weapons platforms.
  – Design analog to digital conversion and multi-color fusion processing architectures for a monolithic infrared focal plane array read-out circuit.
  – Evaluate data throughput, heat dissipation, and circuit fabrication requirements for varying on-focal plane read-out circuit configurations with a goal of increasing read-out capacity by an order of magnitude.
  – Develop, evaluate, and refine fabrication processes for monolithic infrared focal plane arrays in experimental semiconductor microfactory, and transition successful processes to industry consortia members.
  – Enhance large multispectral staring focal plane array technology in support of SMDC's overhead sensor technology for battlefield awareness program.
- 2144 – Complete common source laser brassboard and demonstrate multiple functions in different wavelength bands.
  – Evaluate diode pumped laser source technology and investigate new high peak power laser diode structures for a micro eyesafe laser to reduce the size, weight, and power consumption of manportable laser devices.

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- 4038 – Conduct ATR evaluations of multispectral and large format staring infrared sensors in increasingly complex dynamic operational scenarios.
  – Evaluate SAR ATR capability to include metrics to quantify improvements in situational awareness.
  – Develop mid wave IR staring sensor ATR evaluation capability.
  – Develop adaptable computing hardware to enable real-time ATR processing of multi-sensor data.

FY 1999 Planned Program: (continued)

- 3615 – Demonstrate a real-time multi-spectral (visible, mid infrared and far infrared) synthetic scene rendering capability in sensor prototyping and wargame simulations.
  – Enhance mine signature simulations that accurately represent multiple sensor spectrums and evaluate aided mine detection algorithms in support of land mine center of excellence.
  – Complete comparison between real and synthetic FLIR imagery for ATR evaluation applications.
  – Validate infrared sensor simulation.
- 3900 – Develop uncooled focal plane array device technologies for a low cost solid state near infrared camera that will be capable of day and night operation with sensitivity comparable to present image intensifier tube technology, and improve capability to detect camouflaged targets. Use fusion techniques to add long wave spectral region to provide enhanced driving capability.
  – Demonstrate microsensor uncooled infrared camera weighing less than 70 grams.
  – Develop electronics and image processing components necessary to integrate brassboard solid state, near infrared camera for multispectral imaging in visible and near infrared spectrums.
- 361 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs

Total 19008

FY 2000 Planned Program:

- 4700 – Develop 1024x1024 long wave infrared focal plane array for application to overhead sensor technology for battlefield awareness.
  – Develop and integrate analog to digital conversion circuitry on an infrared focal plane array to reduce read-out circuit noise and improve detector response to target or background temperature differences.
  – Develop and integrate non-uniformity correction circuitry on an infrared focal plane array that will calibrate all detector pixels to provide a uniform response to target or background temperature differences.
  – Test and characterize “P-type” detector material that will allow continuous, end-to-end fabrication of infrared focal plane in a closed semi-conductor environment. Successful development and implementation of this technology will reduced the number of fabrication steps, reduce impurities absorbed in the fabrication process that degrade performance, and lead to higher manufacturing yields.
  – Transition successful fabrication processes for monolithic infrared focal plane arrays to industry consortia members.

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- 914 – Develop prototype fabrication processes for growing next generation, multi-spectral infrared detector arrays directly on a silicon semiconductor read-out circuit.
  – Develop and demonstrate the feasibility of an advanced "plasma etching" process that will enable fabrication of infrared focal plane arrays with smaller detector pixels. Smaller pixels will allow more arrays to be cut from a single detector wafer and provide improved sensor resolution.
- 4700 – Develop a breadboard, temperature stabilized uncooled near infrared camera.
  – Characterize the near infrared sensor's response to eyesafe laser illumination.
  – Collect target and background signature data with near infrared camera to support comprehensive characterization of reflectivity differences of typical "un-modified" targets, camouflaged targets, cultural background objects, and natural background materials.

FY 2000 Planned Program: (continued)

- 3807 – Develop advanced physics based performance, and search/target acquisition models needed to support next Generation FLIR engineering trade studies and operational utility assessments.
  – Develop a virtual engineering, prototyping and simulation environment to support design trade-offs, development, and evaluation of multi-function staring sensor suite, and mine hunter /killer advanced technology demonstrator programs.
  – Extend virtual prototyping and simulation development to support design and evaluation of advanced millimeter wave and synthetic aperture radar systems in order to evaluate adverse weather solution alternatives.
- 1250 – Demonstrate ATR processing architecture for space/volume constrained applications and platforms using adaptable computing technology.
  – Develop partitioning and software translation tools to allow system/hardware specific ATR software to be ported to different processing architectures.
  – Develop synthetic imagery and procedures needed to evaluate and quantify the performance of hyperspectral and multi-sensor mine detection ATRs.
- 1400 – Integrate IR imaging micro-sensors with acoustic and seismic micro-sensor to provide vastly increased threat distinguishing effectiveness of the micro-sensor node.
  – Demonstrate ultra-light, low power, low volume packaging concepts needed for compact, affordable sensor designs.
  – Develop self organizing network of IR micro-sensor arrays to enhance target detection capabilities, define communication links, and training requirements.
- 2100 – Develop low power, high brightness monochrome 1280x1024 flat panel displays and associated drive electronics for future insertion into high resolution, low power dismounted soldier applications.
  – Develop low power monochrome 640x 512 flat panel displays and transition to low power uncooled infrared sensor demonstration.
- 1000 – Develop ultra compact, diode pumped solid state, eyesafe, lasers which are low cost and provide 2 kilometer range performance.
  – Design and fabricate novel laser diode structures to improve peak power output by 5 times over commercial devices.
- 240 – Cooperative Eyesafe Laser Project (CELRAP) (Partner: Japan): Continue to develop a joint performance specification for a multifunctional, eyesafe laser radar for range finding, target profiling, obstacle avoidance, range and terrain mapping. Fabricate subsystems and brassboard.

Total 20111

FY 2001 Planned Program:

- 4825 – Develop and integrate "neuromorphic read-out" circuitry on an infrared focal plane array that will imitate the human eye capability to resolve and distinguish horizontal and vertical edges and to detect trace motion.
  – Develop and implement a prototype process for fabricating on focal plane micro-lens that will focus incident radiation on small pixel detectors and provide improvements in detector sensitivity and sensor performance.
  – Develop and test prototype advance lithography process that will reduce the number of fabrication steps for infrared focal plane arrays.
  – Transition successful lithography fabrication processes for monolithic infrared focal plane arrays to industry consortia members.

FY 2001 Planned Program: (continued)

- 1536 – Develop and test prototype process for semi-conductor microfactory fabrication of optical readout circuitry that will be required to simultaneously read-out the response from high speed, large area (640x480 and 1024x1024), dual color focal plane arrays. Limited capacity read-out circuits are a major technical barrier to higher performing next generation infrared devices.
  – Fabricate, test, and characterize next generation mid-wave and long-wave infrared focal plane array devices that provide high performance at elevated operating temperatures (120K vs current 77K).
- 4850 – Complete testing and evaluation of near infrared solid state cameras based on alternative detector materials, characterize performance, and define manufacturing yield issues for the alternative materials.
  – Define design parameters for a low cost, uncooled near infrared and far infrared sensor for dismounted soldier applications that provides a fused output of the two spectral bands to enhance the operator's perception of "color" contrast, shadows, and depth.
  – Transition technology to advanced development applications for the dismounted soldier, crew served weapons, and driver's vision aids.
- 3370 – Extend physics based performance and search /target acquisition constructive modeling to support additional sensor domains including radar, countermine, and multispectral sensors.
  – Validate multispectral models and simulations for target acquisition, driving, and pilotage applications, incorporate upgrades into virtual engineering prototyping and simulation environment in order to support new sensor concept evaluations and weapon systems trade studies and optimization.
- 1255 – Demonstrate an open "heterogeneous" ATR processor architecture that is capable of hosting ATR software/algorithms designed for unique or propriety hardware, thereby reducing the time and cost required to integrate ATR capability into new platforms.
  – Extend ATR evaluation capability to smart focal plane sensor systems.
- 1590 – Demonstrate small scale integrated network of acoustic, seismic, and imaging micro-sensors that will provide a significant unattended tactical sensing capability to detect, track, and classify time critical mobile and stationary targets.
  – Demonstrate low power consumption from micro-sensors and support electronics that will permit unattended micro-sensor operation for up to 60 days.
  – Perform experiments utilizing prototype micro-sensor nodes in various configurations to optimize warfighter effectiveness.

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•	2200	– Develop full color 640 x 512 flat panel displays to allow dismounted soldiers to utilize color maps and symbology to enhance the soldier's performance. – Develop low power monochrome 1920 x 1080 flat panel displays to allow the soldier to display high resolution image formats (such as high definition TV and high resolution FLIRs) to support future high resolution imaging sensors.
•	240	– Cooperative Eyesafe Laser Project (CELRAP) (Partner: Japan): Continue to develop a joint performance specification for a multifunctional, eyesafe laser radar for range finding, target profiling, obstacle avoidance, range and terrain mapping. Fabricate subsystems and brassboard.
•	1100	– Complete development and evaluate micro diode pumped solid state laser devices and direct laser diode devices for performance, cost, weight, for rangefinder, munition ladars and other requirements.
Total	20966	

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B. Program Change Summary	FY 1998	FY 1999	FY 2000	FY 2001
Previous President's Budget (FY 1999 PB)	16712	19157	18796	19368
Appropriated Value	17304	19157		
Adjustments to Appropriated Value				
a. Congressional General Reductions	-592	-149		
b. SBIR / STTR	-112			
c. Omnibus or Other Above Threshold Reductions	-37			
d. Below Threshold Reprogramming				
e. Rescissions				
Adjustments to Budget Years Since FY 1999 PB			+1315	+1598
Current Budget Submit (FY 2000/2001 PB)	16563	19008	20111	20966